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ARRANGEMENT AND METHOD FOR SESSION CONTROL IN WIRELESS COMMUNICATION NETWORK

5 **Field of the Invention**

This invention relates to session control in communication networks, and particularly (though not exclusively) wireless networks such as UMTS 3G (Universal

10 Mobile Telecommunication System 3rd Generation) mobile wireless networks.

Background of the Invention

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In the field of this invention it is known that the UMTS specifications:

    [1] 3GPP TS 23.107 - 3rd Generation Partnership Project; Technical Specification Group Services

20   and System Aspects; QoS Concept and Architecture (Release 1999)"

    [2] 3GPP TS 27.007 - 3rd Generation Partnership Project; Technical Specification Group Terminals; AT command set for User Equipment (UE) (Release

25   1999)"

    [3] 3GPP TS 23.057 - 3rd Generation Partnership Project; Technical Specification Group Terminals; Mobile Station Application Execution Environment (MExE); Functional description; Stage 2 (Release

30   1999) and

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[4] 3GPP TS 24.008 - 3rd Generation Partnership
    Project; Technical Specification Group Core
    Network; Mobile radio interface layer 3
    specification; Core Network Protocols - Stage 3
5   (Release 1999)
work on the principle that data packets for different
data flows relating to specific services, are carried
over separate packet sessions over the air. For example,
streaming audio packets could be carried over one packet
10 session, web browsing over another, email download over
another, etc. The logic for this is that different QoS
parameters (bandwidth, latency etc.) can be applied to
the different services being used.

15 The UMTS standards [1] define 4 'classes' of packet
flows, based on 4 categories of applications:

  • Conversational class (e.g., interactive voice /
    video)

  • Streaming class (e.g., streaming media such as
20   Internet radio, or streaming video)

  • Interactive class (e.g., web browsing)

  • Background class (e.g., email download).

The corollary of this is that the wireless network needs
25 to know when particular services are being used, so that
it can correctly route data packets for each session over
the relevant packet session over the air.

The UMTS standards imply a tight coupling between the
30 applications and the mobile device, whereby the
applications inform the mobile device (UE) that they are

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starting up, and what are the QoS characteristics of the
traffic they will be sending / receiving. This will
either be a direct, software interface in the case of
integrated mobile devices as in standards [3] or can be
5   an AT command interface as in standards [2].

However, the problem with the approach in the current set
of UMTS specifications is that they require special
versions of application software (email clients, web
10   browsers, video streaming clients, etc.) to implement an
(internal or external) interface to the UE. A standard PC
(Personal Computer), when connected to a UE, with
standard applications, will not support such an interface
and therefore cannot support packet flows of different
15   QoS for different applications, as demanded by the
standards.

A need therefore exists for arrangement and method for
session control in wireless communication network wherein
20   the abovementioned disadvantage(s) may be alleviated.

Stateful inspection is an existing, well-known
technology, used in Internet firewalls - a firewall
blocks packets coming into or out of a network, except
25   those explicitly allowed. Stateful inspection is a
process whereby the firewall inspects packets flowing
into it, implies the state of an application-specific
packet session via the control packets, then allows data
packets for that session to flow through the firewall, if
30   the policy for flows of that type allow it.

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The basic example of stateful inspection is the allowing
through of TCP (Transmission Control Protocol) sessions
originated from inside the firewall to an IP (Internet
Protocol) address on the outside to be allowed, but TCP
5   sessions from outside to be blocked - this is the
mechanism that allows through web browsing and FTP (File
Transfer Protocol) requests from the inside of a
firewall, but blocks requests from the outside to web
servers inside the firewall.
10

This is done by catching TCP connection request packets
(packets originating from inside the firewall with the
'SYN' flag set), starting the TCP '3-way handshake' (as
explained, for example, in Chapter 18 of "TCP/IP
15   Illustrated, Volume 1, The Protocols" authored by W.
Richard Stevens and published by Addison Wesley), then
opening up the source and destination IP addresses and
TCP port numbers, forwarding on the packet to the outside
and then monitoring the subsequent TCP control packets to
20   ensure the connection came up and also to catch the
eventual tear-down of the TCP session.

Another example of stateful inspection in firewalls for a
UDP-based (User Datagram Protocol-based) service is to
25   allow voice over IP (VoIP) calls through the firewall. In
this example, incoming VoIP call-control messages are
inspected and parsed to reveal the VoIP end-points (IP
address and port number) and allow voice data packets
through the firewall.
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Statement of Invention

In accordance with a first aspect of the present
invention there is provided an arrangement for session
5   control in a wireless communication network as claimed in
claim 1.

In accordance with a second aspect of the present
invention there is provided a method for session control
10   in a wireless communication network as claimed in
claim 19.

Brief Description of the Drawings
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One arrangement and method for session control in a
wireless communication network incorporating the present
invention will now be described, by way of example only,
with reference to the accompanying drawings, in which:
20

    FIG. 1 shows a schematic diagram illustrating prior
    art data flow across an Internet network firewall
    between an inside host and an outside host, and
    showing set-up and tear-down of a session;
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    FIG. 2 shows a schematic diagram illustrating prior
    art VoIP data flow across an Internet network
    firewall between a PC and an Internet Protocol
    telephone set and showing set-up and tear-down;
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FIG. 3 shows a schematic diagram of an arrangement illustrating application of stateful inspection to UMTS session management, in the context of POP3 email download, which is mapped to a 'background class' PDP context, in accordance with the present invention;

FIG. 4 shows a block schematic diagram illustrating flow of data packets in a default PDP context of the arrangement of FIG. 3;

FIG. 5 shows a block schematic diagram illustrating detection of email download session control packets to activate a secondary PDP context for the email download session in the arrangement of FIG. 3;

FIG. 6 shows a block schematic diagram illustrating flow of email packets and other data packets, and their respective processing as two parallel contexts, during the email download session in the arrangement of FIG. 3;

FIG. 7 shows a schematic diagram of an arrangement, similar to FIG. 3, illustrating the use of simultaneous default and secondary PDP contexts to provide separate PDP contexts for the email and data packets of FIG. 6;

FIG. 8 shows a block schematic diagram illustrating flow of data packets in a default PDP context;

FIG. 9 shows a block schematic diagram illustrating detection of VoIP session control packets to activate a secondary PDP context for controlling a VoIP session;

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FIG. 10 shows a block schematic diagram illustrating flow of VoIP session control packets, VoIP packets and other packets, and their respective processing as two parallel contexts, during a VoIP session;

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FIG. 11 shows a block schematic diagram of a UMTS network, in which packet sessions (PDP contexts) are created between UE and SGSN and forwarded on through to the GGSN, where the various packet sessions are

15   bonded back together and connected to the target network (e.g., the Internet) in a single packet stream, in accordance with the invention;

FIG. 12 shows a block schematic diagram illustrating

20   UE packet flow architecture in an uplink direction, in accordance with the invention, in the network of FIG. 11; and

FIG. 13 shows a block schematic diagram illustrating

25   UE packet flow architecture in a downlink direction in accordance with the invention, in the network of FIG. 11.

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Description of Preferred Embodiment(s)

Referring firstly to FIG. 1, a known Internet network
firewall 10 intermediates between an inside host 20 and
5   an outside host 30. Operation of the firewall 10 is as
follows:

- At (1), session set-up begins when an outgoing TCP
  connection detected. The firewall 10 is opened up
  for remote IP address and source and destination TCP
10   port numbers, and waits for a SYN response; a
  session object created by a stateful inspector (not
  shown).

- At (2), the end of 3-way handshake detected, and 2-
  way TCP session packets are allowed to flow.

15 - At (3), the start of TCP connection tear-down
  detected with a FIN packet from the inside host 20.

- At (4), the TCP session teardown is complete, and
  far end IP address & session TCP port numbers are
  blocked by the firewall 10.

20

Referring now to FIG. 2, a known Internet network firewall
110 intermediates VoIP data flow between a PC (Personal
Computer) 120 and an Internet Protocol telephone set 130.
Operation of the firewall 110 is as follows:

25 - At (1), session set-up begins when an outgoing SIP
  session request (INVITE) is detected. The firewall
  110 is opened up for remote IP address and source and
  destination port numbers for SIP control messages,
  and waits for an ACK response; a session object is
30   created by a stateful inspector (not shown).

- At (2), a successful ACK is received, and UDP source
  and destination port numbers are opened up for an
  RTP session, based on fields parsed out of INVITE
  and ACK messages. 2-way UDP voice session packets
  are allowed to flow.

- At (3), start of SIP connection tear-down is
  detected.

- At (4), SIP session teardown is complete, and far
  end IP address and session UDP port numbers are
  blocked by the firewall 110.

However, the firewalls 10 and 110 are known only in
fixed-line, i.e., wired, applications.

The UMTS standards define 4 'classes' of packet flows,
based on 4 categories of applications (conversational
class - e.g., interactive voice / video; streaming class
- e.g., streaming media such as Internet radio, or
streaming video; interactive class - e.g., web browsing;
and background class - e.g., email download).

The wireless network therefore needs to know when
particular services are being used, so that it can
correctly route data packets for each session over the
relevant packet session over the air.

The UMTS standards imply a tight coupling between the
applications and the mobile device, whereby the
applications inform the mobile device (UE) that they are
starting up, and what are the QoS characteristics of the
traffic they will be sending / receiving. This will

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either be a direct, software interface in the case of
integrated mobile devices as in standards, or can be an
AT command interface as in standards.

5   However, the problem with the approach in the current set
of UMTS specifications is that they require special
versions of application software (email clients, web
browsers, video streaming clients, etc.) to implement an
(internal or external) interface to the UE. A standard PC
10   (Personal Computer), when connected to a UE, with
standard applications, will not support such an interface
and therefore cannot support packet flows of different
QoS for different applications, as demanded by the
standards.

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In a preferred embodiment, the present invention
overcomes this drawback by applying Stateful Inspection
to UMTS Session Management.

20   Briefly stated, in a preferred embodiment, stateful
inspection is used in a UTRA (UMTS Terrestrial Radio
Access) system to examine the data packets, to detect the
existence of different application-specific packet flows,
which then allows packet-sessions, called PDP (Packet
25   Data Protocol) contexts in the UMTS standards, to be
created over the air with the required QoS parameters.

The UE brings up a default PDP context for basic data
service; all packets are then inspected, both incoming
30   and outgoing, and application-specific traffic is used to
open-up dedicated PDP contexts to carry that traffic.

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One example of how this is used is detection of a POP3
email download, mapping it to a 'background class' PDP
context.

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As depicted in FIG. 3, a PC 210 (generally referred to as
TE – Terminal Equipment – in UMTS terminology) is
coupled, via R interface 215, to UMTS UE 220 (containing
a USIM – not shown – which together with the UE forms MT

10   – Mobile Terminal – in UMTS terminology). The UE 220 is
coupled through the UMTS radio access and core network
230 via at least a default PDP context 240. The UMTS
radio access and core network 230 is coupled via a Gi
reference point 250) to the Internet 260, containing an

15   email server 270.

Referring now also to FIG. 4, FIG. 5 and FIG. 6, the UE
220 contains a stateful inspection session monitor 280.

20   As shown in FIG. 4, the stateful inspection session
monitor 280 monitors packets 290 on the default PDP
context 240, looking for email download control messages.
In the absence of an email download control message, the
UE 220 processes the data packets 290 through RLC (Radio

25   Link Controller) 300, MAC (Medium Access Controller) 310
and CDMA (Time-Division Code-Division-Multiple-Access)
physical air interface 320 in known manner.

As shown in FIG. 5, when the stateful inspection session

30   monitor 280 detects an email download control message
330, it causes a session manager 340 to activate a

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secondary PDP context 350. In the activated secondary PDP
context 350, the email download control packet(s) are
processed through RRC (Radio Resource Controller) 360,
RLC 370, MAC 380 and CDMA physical air interface 390 in
5   known manner.

As shown in FIG. 6, after activation of the secondary PDP
context 350, data packets 290 and email packets 400 are
processed in parallel in separate PDP contexts as
10   follows:

    • data packets 290 are processed in default PDP
      context 240, and

    • email packets 400 are processed in PDP context 350.

15   Thus, as shown in in FIG. 7, the email download session
     is conducted between the email server 270 and an email
     program 410 (running on the PC 210) via the PDP context
     350, while the default PDP context 240 continues to
     process data packets as before.

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Referring now to FIG. 8, FIG. 9 and FIG. 10, another
example application of the present invention, is a VoIP
session initiation using SIP (as in 3GPP RFC - Request
For Comments - 3261 "SIP: Session Initiation Protocol",
25   June 2002) which is mapped into a conversational class
     PDP context to carry the VoIP traffic and an interactive
     class PDP context to carry the VoIP signalling.

As shown in FIG. 8, the stateful inspection session
30   monitor 280 monitors packets 290 on the default PDP
     context 240, looking for VoIP session control packet(s).

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In the absence of a VoIP session control packet, the UE
220 processes the data packets 290 through RLC (Radio
Link Controller) 300, MAC (Medium Access Controller) 310
and CDMA (Time-Division Code-Division-Multiple-Access)
5   physical air interface 320 in known manner.

As shown in FIG. 9, when the stateful inspection session
monitor 280 detects VoIP session control packet(s) 420,
it causes session manager 340 to activate a secondary PDP
10   context 350. In the activated secondary PDP context 350,
the VoIP session control packet (s) are processed through
RRC (Radio Resource Controller) 360, RLC 370, MAC 380 and
CDMA processor 390 in known manner. Referring now also to
FIG. 10, detection of VoIP session control packet(s) also
15   causes SM 340 to activate a further secondary PDP context
430.

As shown in FIG. 10, after activation of the secondary
PDP context 350 and the further secondary PDP context
20   430, packets are processed in parallel in three PDP
contexts as follows:
   • data packets 290 are processed in default PDP
     context 240,
   • VoIP control packets 420 are processed in PDP
25   context 350, and
   • VoIP packets are processed in PDP context 430.

Taking the specific example of the Session Initiation
Protocol [RFC 3261 - SIP: Session Initiation Protocol,
30   June 2002] the QoS parameters required for a particular

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VoIP session can be derived or inferred from the SIP
signalling.

A request to set up a session is contained in an INVITE
5   message, e.g.
        INVITE sip:UserB@there.com SIP/2.0
        Via: SIP/2.0/UDP here.com:5060
        From: BigGuy
        To: LittleGuy
10   Call-ID: 12345601@here.com
        CSeq: 1 INVITE
        Contact:
        Content-Type: application/sdp
        Content-Length: 147

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        v=0
        o=UserA 2890844526 2890844526 IN IP4 here.com
        s=Session SDP
        c=IN IP4 100.101.102.103
20   t=0 0
        m=audio 49172 RTP/AVP 4
        a=rtpmap:4 G723/8000

    In this case the 'c=' parameter identifies the IP address
25   of the caller, the 'm=' parameter identifies this as an
    RTP audio stream with local UDP port number and the 'a='
    parameter identifies the characteristics (bandwidth,
    encoding) of the audio stream.

30   The response message indicating answer to this might be:
        SIP/2.0 200 OK

```
        Via: SIP/2.0/UDP here.com:5060
        From: BigGuy
        To: LittleGuy ;tag=8321234356
        Call-ID: 12345601@here.com
5       CSeq: 1 INVITE
        Contact:
        Content-Type: application/sdp
        Content-Length: 147


10      v=0
        o=UserB 2890844527 2890844527 IN IP4 there.com
        s=Session SDP
        c=IN IP4 110.111.112.113
        t=0 0
15      m=audio 3456 RTP/AVP 4
        a=rtpmap:4 G723/8000
```

In this case the 'c=' parameter identifies the IP address
of the called party, the 'm=' parameter identifies this
20 as an RTP audio stream with a type 4 (6.3 kbit/s G.723.1)
codec & local UDP port number of the called party and the
'a=' parameter identifies the characteristics of the
audio stream - basically the codec.

25 Finally the ACK message sent by the caller looks like:

```
        ACK sip:UserB@there.com SIP/2.0
        Via: SIP/2.0/UDP here.com:5060
        From: BigGuy
30      To: LittleGuy ;tag=8321234356
        Call-ID: 12345601@here.com
```

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CSeq: 1 ACK

So, by this time the source and destination IP addresses
and port numbers + the bandwidth required are known –
5   basically enough to set-up a secondary PDP context to
send the packets through.

It will be understood that the application of stateful
inspection of packet flows to control UMTS session
10 management as described in the examples above presents a
new and advantageous technique providing a UE interface
allowing packet flows of different QoS for different
applications to be supported simultaneously and in
parallel, without requiring special versions of
15 application software (email clients, web browsers, video
streaming clients, etc.).

Referring now to FIG. 11, viewed in the context of the
UTRA system of FIG. 3 or FIG. 7, the VoIP example
20 described above in relation to FIG. 8, FIG. 9 and FIG. 10
can be considered as:

    (i)   in the UE (220), detecting application-specific
             session initiation (incoming or outgoing) and
             setting up secondary PDP contexts to carry
25   application packet streams (350 and 430), and
    (ii)   in GGSN 230C, GTP (GPRS Tunneling Protocol)
             sessions from SGSN 230B extending the PDP
             contexts all the way to the GGSN. The GGSN can
             use the per-PDP context QoS parameters (and any
30   other criteria it sees fit) to classify the IP
             traffic going into the target IP network.

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Thus, in a UMTS network, packet sessions (PDP contexts)
are created between the UE and the SGSN (via the Node B -
not shown - and RNC 230A) and forwarded on through to the
5   GGSN, where the various packet sessions are bonded back
together and connected to the target network (e.g. the
Internet) in a single packet stream.

It will be understood that although the invention has
10   been described in the above examples with reference to
email (POP3) and VoIP sessions, the invention covers
additional or alternative sessions such as:
'conversational' class (e.g., Video over IP) where
traffic may be based on originated calls controlled by
15   SIP or H.323 protocol; 'streaming' class (e.g., carrying
streaming media traffic controlled by Real Time Streaming
Protocol); 'interactive' class; or 'background' class
(e.g., carrying POP3 or SMTP traffic).

20   It will be understood that stateful inspector and packet
filter entities exist within the UE; these may be
implemented in software, firmware or hardware. The
stateful inspector fits in the uplink and downlink packet
flow, the packet filter fits in the uplink packet flow
25   (in order to control the split of uplink packets into the
correct PDP context). A session management software
entity exists within the UE; it controls the activation
and de-activation of PDP contexts. The relationship
between stateful inspector, packet filter and session
30   management is illustrated in the FIG. 12 and FIG. 13

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Referring now to FIG. 12 and FIG. 13, which show uplink and downlink packet flow architectures respectively in the UE   (220 or 130A):

5   The stateful inspector 450:

- Detects application-specific control messages in the uplink and the downlink.

- Implements an interface to the session management entity 460 to control activation / deactivation of
10   application-specific PDP contexts, including sufficient information regarding the IP packet flow for that instance of that application (source / destination IP address, UDP/TCP indicator and source / destination port number).

15 - Implements an interface from session manager 460 to inform it of timed-out sessions.

Session manager 460:

- Implements the interface from the stateful inspector
20   450 to initiate activation / de-activation of secondary PDP contexts.

- Controls the activation / de-activation of secondary (application-specific) PDP contexts over the UMTS air interface.

25 - Implements an interface to add / delete with uplink packet-flow filters in the packet filter entity 470 (source / destination IP address, UDP/TCP indicator and source / destination port number).

30   The packet filter 470:

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- • Implements the interface from session manager 460 to
add / remove packet filters and associate them to
secondary PDP contexts in the uplink.

5   It will be appreciated that the method described above
for session management in a UMTS radio access network may
be carried out in software running on a processor (not
shown), and that the software may be provided as a
computer program element carried on any suitable data
10   carrier (also not shown) such as a magnetic or optical
computer disc.

It will be also be appreciated that the method described
above for session management in a UMTS radio access
15   network may alternatively be carried out in hardware, for
example in the form of an integrated circuit (not shown)
such as an FPGA (Field Programmable Gate Array) or ASIC
(Application Specific Integrated Integrated Circuit).

20   It will be understood that the arrangement and method for
session control in a wireless communication network
described above provides the advantage of allowing
session set-up and tear-down control of dedicated packet
sessions for particular data services, in a UMTS 3G
25   mobile wireless network, with application-specific QoS
parameters, without the explicit cooperation of the
application software (either via software API or modem AT
command).